# Near Field Communication (NFC)

## Safe and Convenient NFC Technology and Test

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ROHDE&SCHWARZ

# Agenda

- **Near Field Communication (NFC) Basics**
  - Technology overview
  - Applications of NFC
  - Different NFC modes
  - NFC Data transfer principles
- **NFC Forum and Tests**
- **Rohde&Schwarz Solution**

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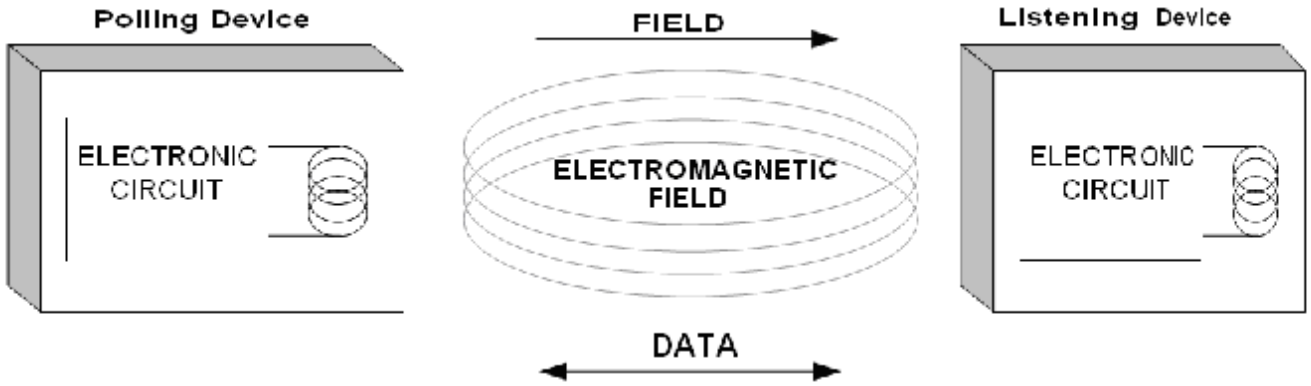
# What´s NFC?
# A summary

- **General informationen on Near Field Communication:**
  - Wireless data interface between devices
  - Data transmission uses high-frequency magnetic alternating fields in the frequency range of 13.56MHz
  - Communication range of  several centimetres
  - Data rates of 106 kbit/s, 212 kbit/s and 424 kbit/s
  - Two different communication modes: passive or active
  - Three wireless interfaces are defined (NFC-A, NFC-B, NFC-F)



# Background story

## RFID Technology

Contactless Identification via radio transmission
Military: Identification, friend or foe
Civilian: Access control, retail security
Standardization ISO 14443

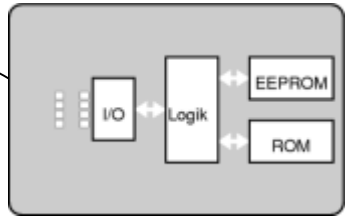
Typical frequency ranges:
LF: 125 kHz, 134 kHz (long wave)
HF: 13.56 MHz (short wave)
UHF: 433 MHz, 868 MHz (decimetric wave)

## Smartcard Technology

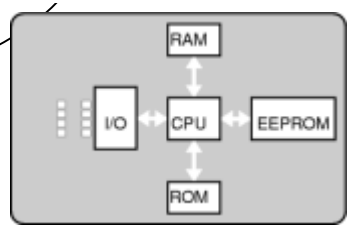
First: Magnetic strip
Then: Chip card memory (1984)
Today: Chip card processor,
crypto processors (1995)
Standardization EMV®

## Contactless chip card systems

NXP: Mifare
SONY: Felica
Based on RFID technology




Chip card memory

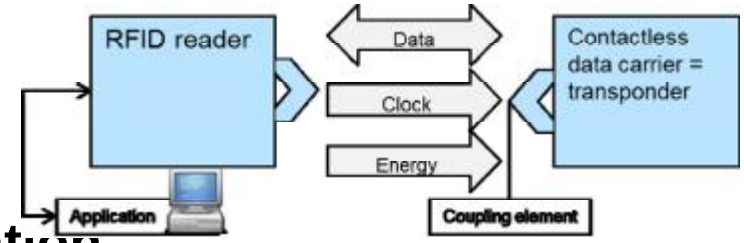



Chip card processor

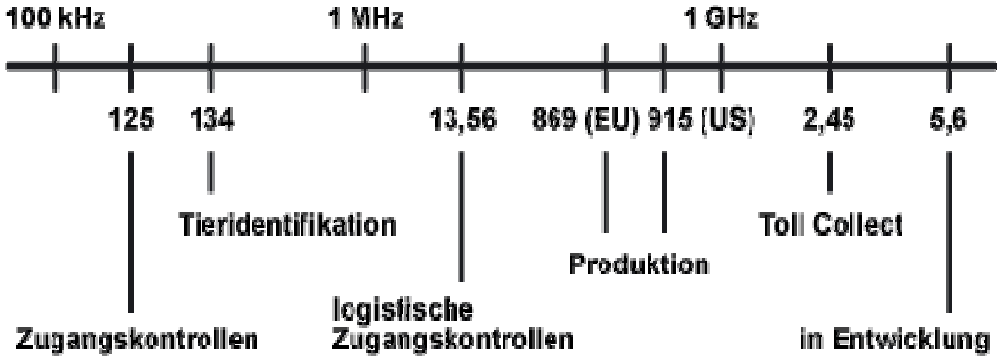
## NFC

Mifare = Mikron Fare Collection System
Felica = Felicity Card
EMV® = Europay,Mastercard,Visa

# RFID Radio Frequency Identifcation



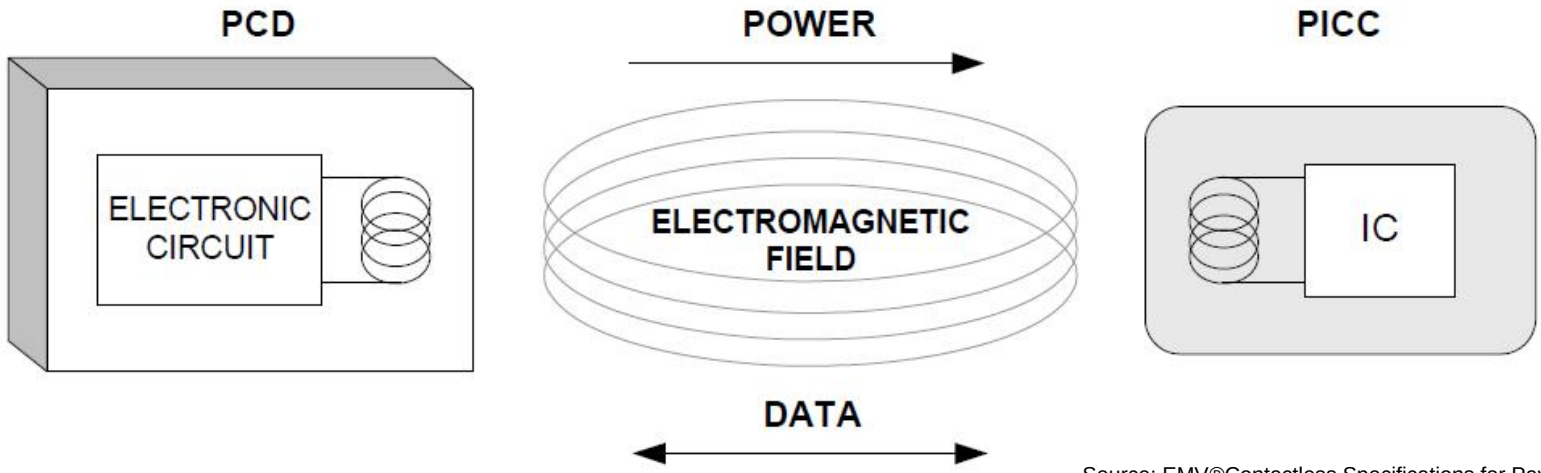

- **Contactless short distance communication**
- **Used for automatic identification and tracking**
- **Information can be stored on tags and read from up to several meters away**
- **Different types of tags**
- **Standards: e.g. ISO/IEC 14443 or JIS X6319-4**
- **Frequencies in the range of 100 kHz – 6 GHz**




*EPC = 96 Bit Electronic Product Code

# Contactless Chip Card Systems

| Chip card | Abbreviation | Distance | Standard | Remark |
|---|---|---|---|---|
| Close Coupling Integrated Chip Card | CICC | Up to 1 cm | ISO 10536 | |
| **Proximity Integrated Chip Card** | **PICC**<br><br>**PCD = Proximity Coupling Device** | **Up to 10 cm** | **ISO 14443**<br>**Typ A**<br>**Typ B**<br>**ISO 18092**<br>**(JIS X 6319-4)** | <br>**NFC-A**<br>**NFC-B**<br><br>**NFC-F** |
| Vicinity Integrated Chip Card | VICC | Up to 1 m | ISO 15693 | Data rates up to 26 kbit/s |




Source: EMV®Contactless Specifications for Payment Systems

# Smartphones with NFC (Source: www.nfcworld.com, 05.03.2012)

… Acer E230 … **Blackberry** Bold 9790/9900/9930 … Blackberry Curve 9350/9360/9370/9380 … Casio DT-X8/IT-800 … Fujitsu Arrows F-07D … **Samsung** Galaxy Nexus/Note/SII … **Google** Nexus S … HTC Incredible … **HTC** Ruby … Huawei Sonic … Kuoziro FT701W … LG Optimus LTE/Net … **LG** T530 Ego … Mobiwire Cosyphone … **Motorola** Droid Razr … Motorola MC75A HF … **Nokia** 603/700/701/c7/Astound/N9/Oro … Panasonic BizPad … Pantech Sky Vega LTE … Porsche Design P‘9981 … Prada phone by LG … Samsung S5230/ S5260 NFC … Samsung SHW-A170K … Samsung Wave 578/M/Y … Sky Vega Racer … Sonim XP1301 Core NFC … Sonim XPand NFC … **Sony** Xperia S … Turkcell T11 Maxiphone

……

# NFC applications

**Connect Electronic Devices**
**"Touch to Connect"**

- Set up wireless home office connections
- Access buildings and events
- Touch your camera to a printer to print

**Access Digital Content**
**"Touch to Read"**

- Read smart posters
- Share business cards

**Make Contactless Transactions**
**"Touch to Transact"**

- Pay for goods and services
- Buy transit tickets, and access trains, planes, etc.

Source: NFC Forum

# NFC applications

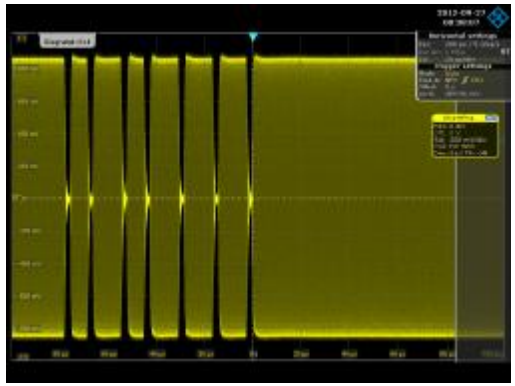
- **Application areas of Near Field Communication:**
  - Touch and Go: e.g. access control, ticketing systems
  - Touch and Confirm: e.g. mobile payment
  - Touch and Capture: e.g. read out phone numbers, URLs
  - Touch and Link: online connection of NFC device required; data read forwarded via an online connection to a server
  - Touch and Connect: connection of two NFC devices, e.g. transmitting MP3, image
  - Combination of the above: e.g. Touch&Travel for buying train tickets

# NFC operating modes

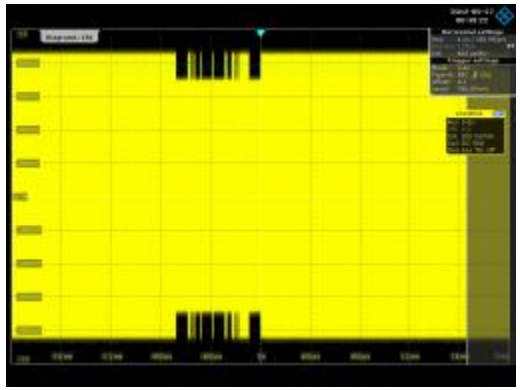
- **Peer – to – Peer (p2p) Mode**
  - Two NFC devices can exchange data
  - E.g. digital photos, virtual business cards, …
- **Reader / Writer Mode („RFID“ Mode)**
  - NFC device can read and/or write tags
  - The tags can be placed on objects like information signs, packaging, documents, …
- **Card – Emulation – Mode**
  - The NFC device behaves like a contactless smart card
  - E.g. contactless payment (credit card funcionality), electronic ticket, identification …

# Data transfer between NFC devices
# A summary

- **Uplink**: Data transfer from Reader/Writer (active device) to Transponder (passive device) or active peer-to-peer communication
  - ASK (amplitude shift keying)
    - NFC-A: 100% ASK
    - NFC-B / NFC-F: 10% ASK



NFC-A SensReq



NFC-B SensReq

- **Downlink**: Data transfer from Transponder (passive device) to Reader/Writer (active device)
  - Load Modulation

# NFC Transmission Technique: Summary

| NFC Type | | Coding | Modulation | Data rate | Frequency |
|---|---|---|---|---|---|
| NFC-A | Uplink | Modified Miller | 2-ASK 100% | 106 kbit/s | 13.56 MHz |
| | Downlink | Manchester | Load modulation (ASK) | 106 kbit/s | 13.56 MHz ± 848 kHz subcarrier |
| NFC-B | Uplink | NRZ-L | 2-ASK 10% | 106 kbit/s | 13.56 MHz |
| | Downlink | NRZ-L | Load modulation (BPSK) | 106 kbit/s | 13.56 MHz ± 848 kHz subcarrier |
| NFC-F | Uplink | Manchester | 2-ASK 10% | 212 / 424 kbit/s | 13.56 MHz |
| | Downlink | Manchester | Load modulation (ASK) | 212 / 424 kbit/s | 13.56 MHz |

Uplink = Poller to Listener
Downlink = Listener to Poller

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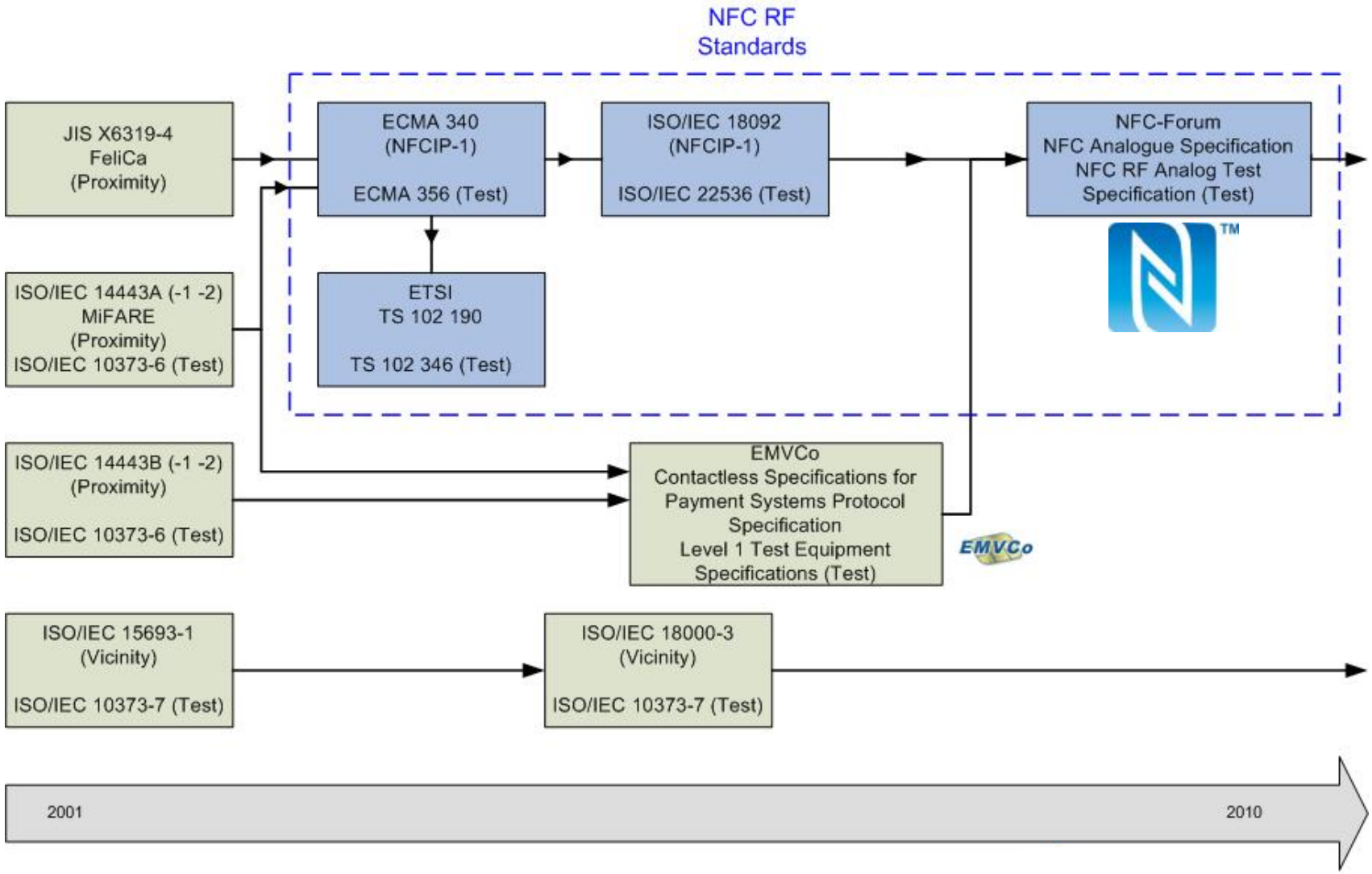
# NFC Forum™

- **Founded 2004 by NXP, Nokia und Sony**
- **Non-Profit Industry Association with 180 members**
- **Goal: Advance the use of NFC technology**
  - Ensuring interoperability among devices and services
  - Educating the market about NFC technology
  - Development of specifications
- **NFC Forum Certification Program**
  - Establishing that products conform to the NFC Forum´s specifications

The Certification Program offers increased assurance that NFC Forum-certified products are **interoperable** with other NFC Forum-certified products. It also supports **consistency** in the behavior of NFC devices by confirming that products conform to NFC Forum specifications.

- **www.nfc-forum.org**

# NFC Standards Evolution

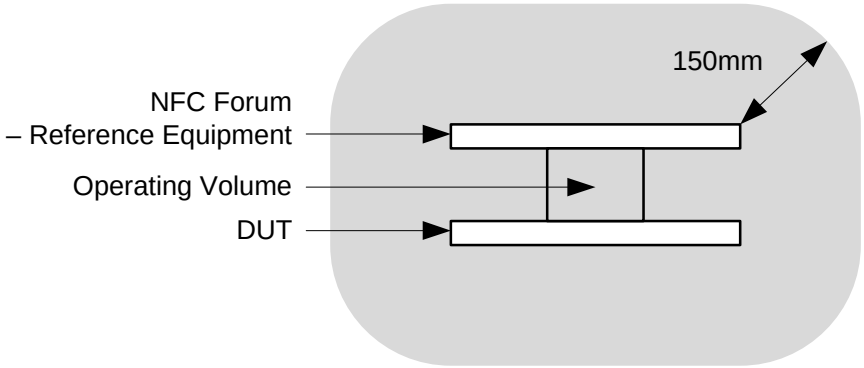


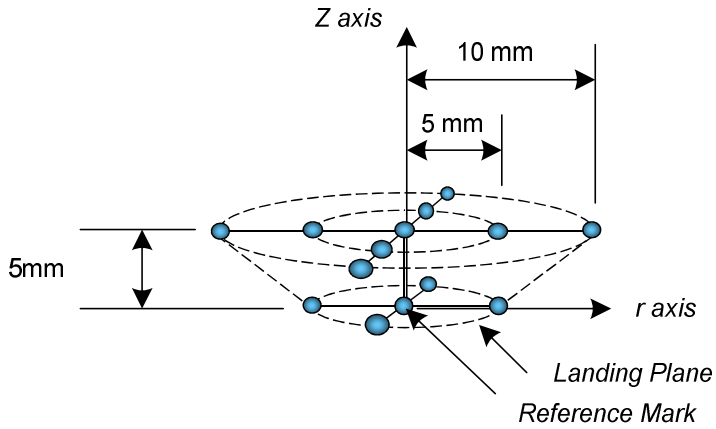
# RF Tests on NFC Devices

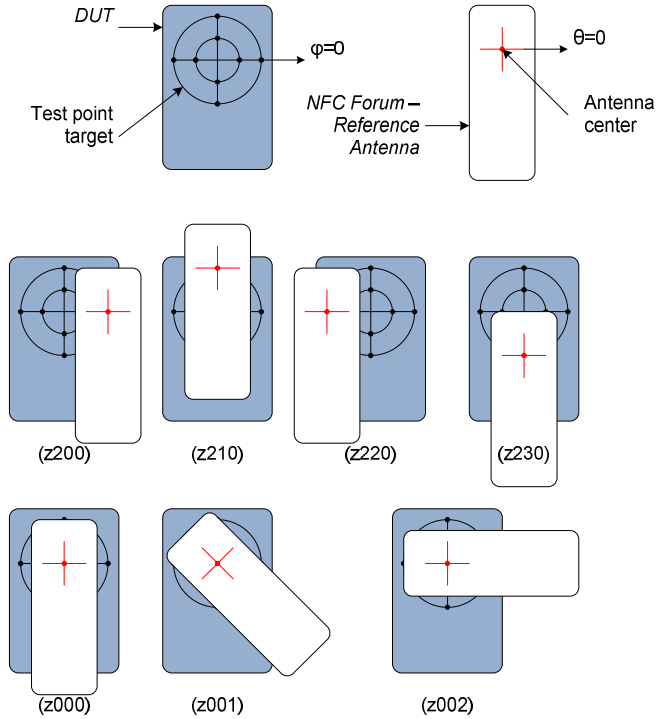
- **In active polling mode**
  - Carrier Frequency Accuracy
  - Power Level measurement
  - Waveform Characteristic Measurement (Timing parameters)
  - Load Modulation Sensitivity
  - Threshold level test
- **In passive listening mode**
  - Load Modulation Amplitude Measurement
  - Power reception test
  - Frame delay time

- Tests are to be carried out in all different modes (NFC-A, NFC-B and NFC-F if supported by the device)
- 14 test positions are defined by the NFC Forum

# NFC RF Measurements: DUT Positioning



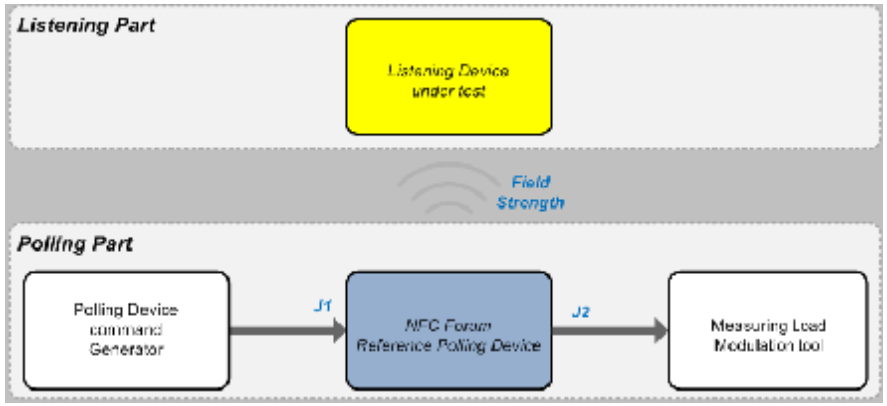



# NFC RF Measurements

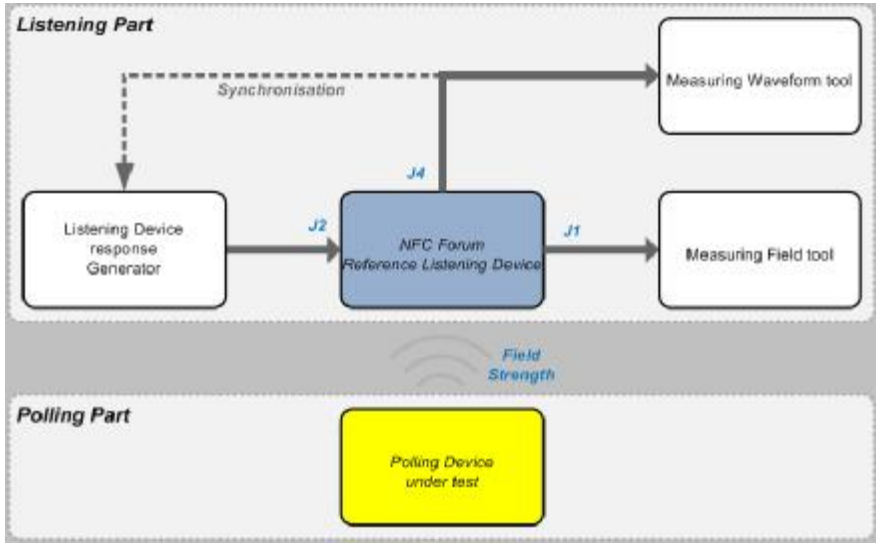
## Test Setups

- To ensure NFC devices conforming to standards (NFC Forum Analogue Test Specification).
- RF tests are defined by reference devices (poller or listener from NFC Forum) and these devices correspond to a typical NFC devices in polling and listening mode with different antenna sizes .

**Listening Test**




**Polling Test**



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# R&S©RTO Digital Oscilloscope

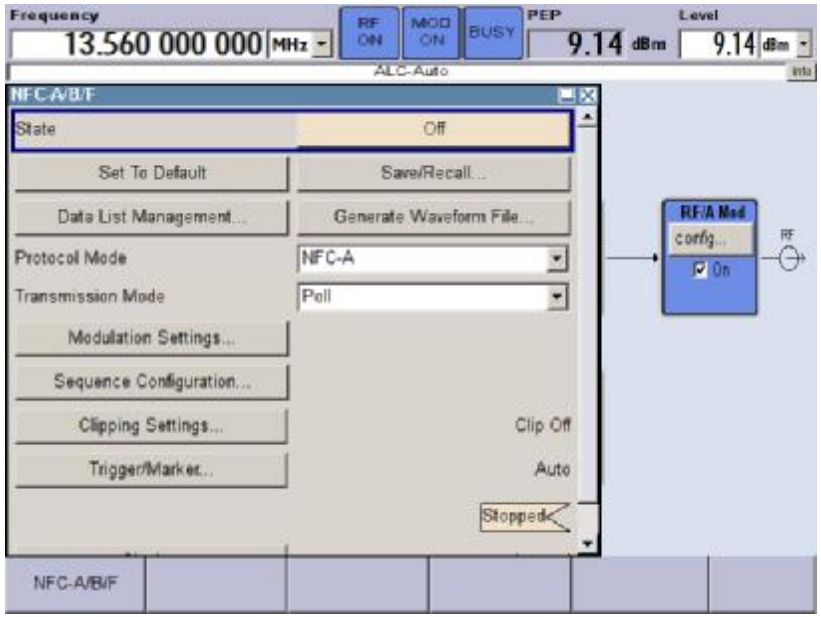
- For capturing the NFC waveform sequence
- Software option RTO-K11 for acquiration of modulated signals and output of I/Q data for further analysis (e.g. with FS-K112PC NFC Measurement Software)
- Dedicated NFC trigger for NFC-A, NFC-B and NFC-F for fast and easy triggering on NFC waveforms

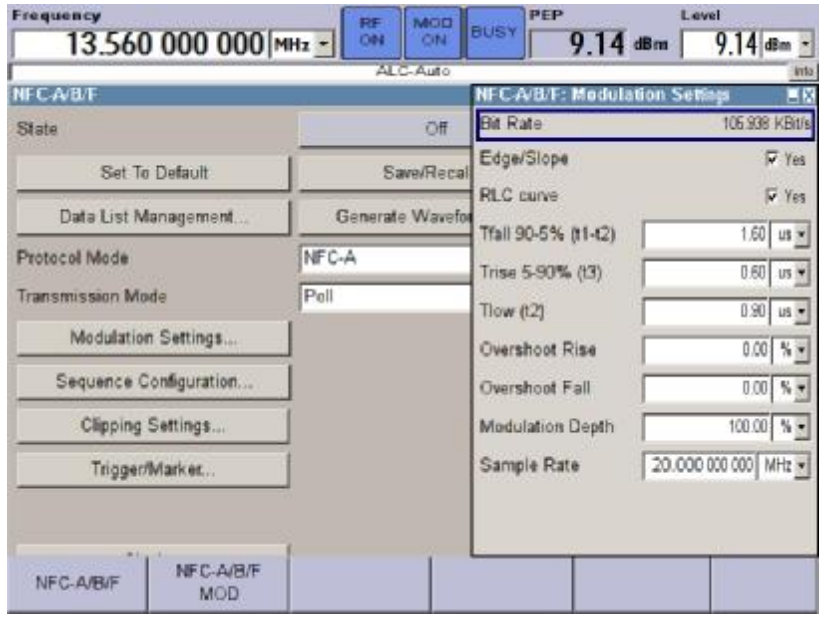
# NFC Measurement Software R&S©FS-K112PC

- Analysis of RF-parameters of NFC-A, NFC-B and NFC-F signals of poller and listener devices
- Automatic detection of NFC standard, alternatively manual selection
- Measurement of power versus time, modulation depth, modulation index, load modulation amplitude
- Measurement of timing parameters (rise time, fall time, frame delay time, overshoot, undershoot)
- Limit check according to the NFC Analogue Specification
- Presentation of transferred data, analyzed commands and responses (e.g. SENS REQ) and graphical representation of recorded signals and power versus time
- Support of R&S®FSV Signal and Spectrum Analyzer, R&S®FSL Spectrum Analyzer, R&S® ZVL network analyzer and R&S®RTO Digital Oscilloscope

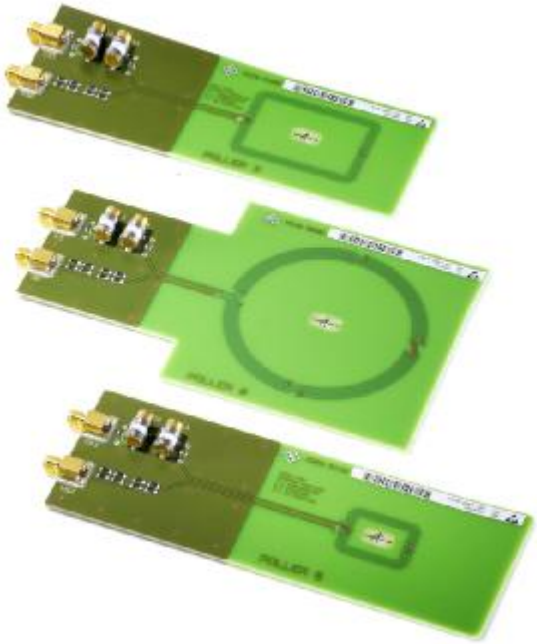
# R&S©SMBV Vector Signal generator

- For generation of NFC polling commands and listening responses
- *Soon to come:* NFC Personality SMBV-K89 which allows fast and easy generation of user defined NFC listener and poller sequences on the fly (no additional PC required)



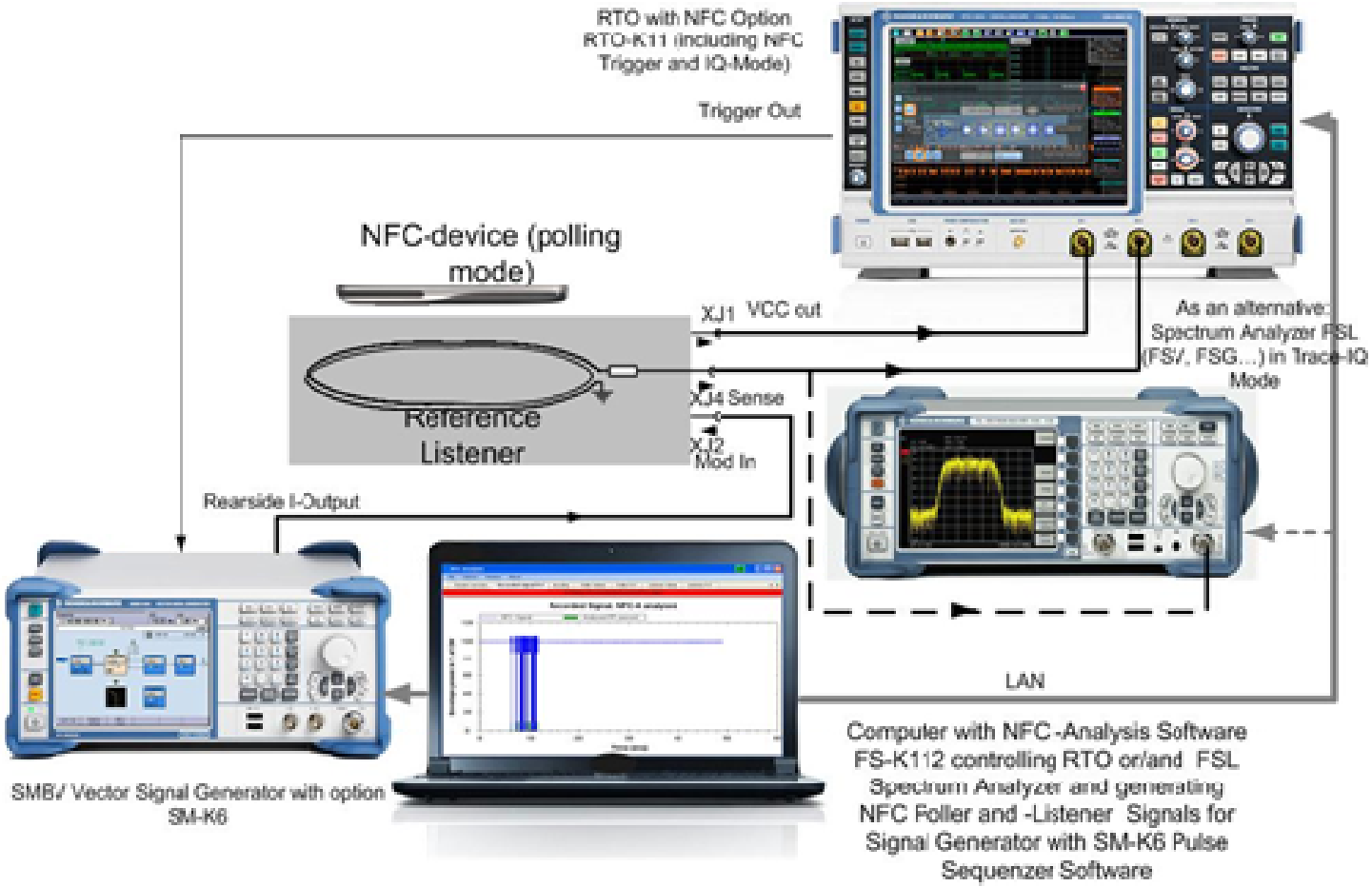
# NFC Forum Reference Devices



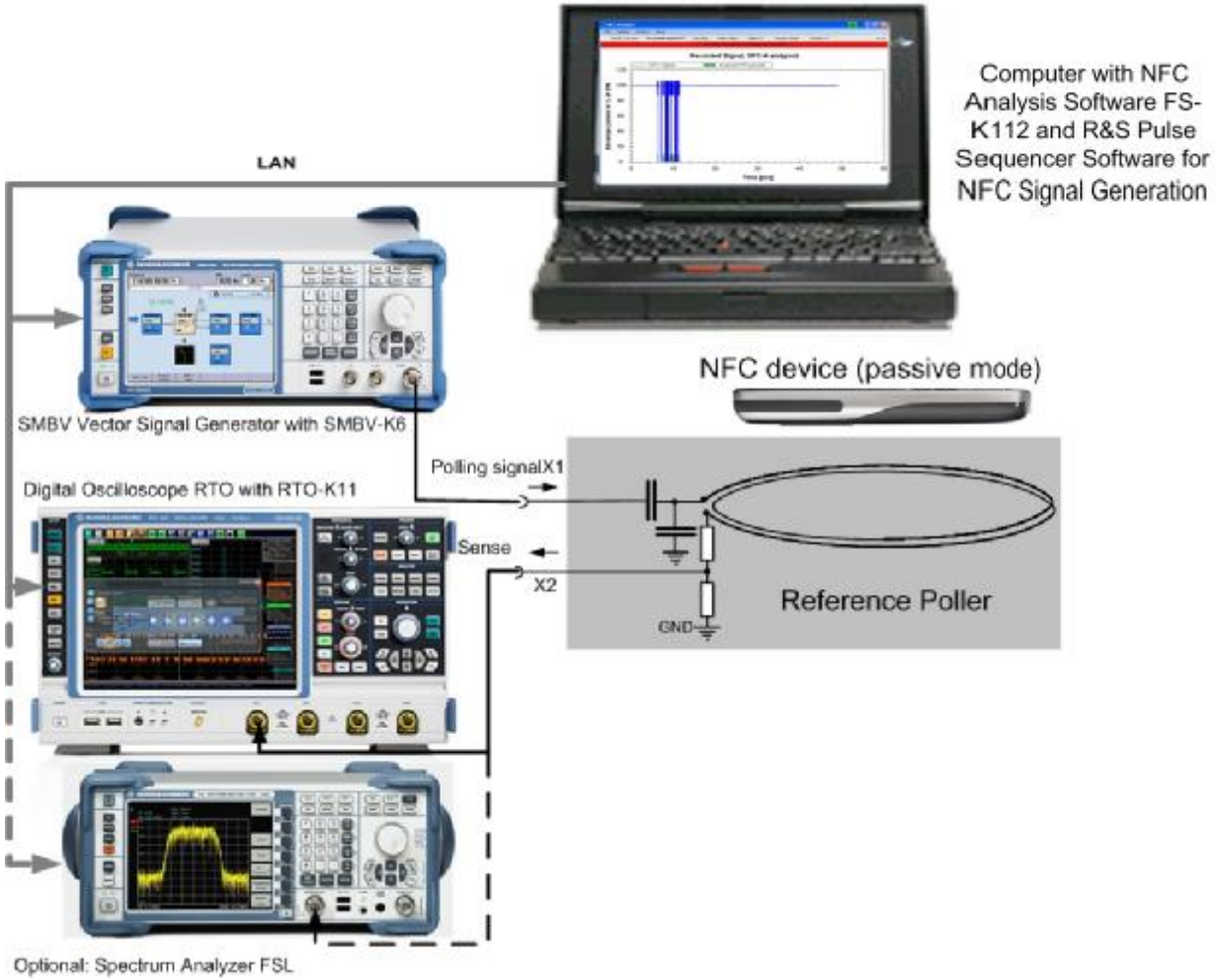
- **Polling devices according to the NFC Forum Analogue Specification**
  - **Three different antenna coil designs**
  - **Can be used together with R&S®SMBV Signal Generator to simulate a polling device**
  - **Can be used together with R&S®RTO Digital Oscilloscope and R&S®FS-K112 for capturing and analyzing the response from a listening device**

- **Listening devices according to the NFC Forum Analogue Specification**
  - **Three different antenna coil designs**
  - **Combined with R&S®RTO Digital Oscilloscope and R&S®FS-K112 signals sent by a polling device can be captured and analyzed**
  - **Combined with R&S®SMBV Signal Generator**
  - **listener responses can be send to the polling device**

# Manual Test Setup for Polling Mode with NFC Measurement Software FS-K112PC



# Manual Test Setup for Listening Mode with NFC Measurement Software FS-K112PC



# Read more about NFC on our web page

Near Field Communication (NFC) Technology and Measurements
White Paper
Near Field Communication (NFC) is a new short-range, standards-based wireless connectivity technology, that uses magnetic field induction to enable communication between electronic devices in close proximity. Based on RFID technology, NFC provides a medium for the identification protocols that validate secure data transfer. NFC enables users to perform intuitive, safe, contactless transactions, access digital content and connect electronic devices simply by touching or bringing devices into close proximity.
This White Paper gives an overview of NFC uses, NFC technology and signals, RF measurements on NFC units and shows some examples of measurement results with R&S test instruments and R&S software tools.
ROHDE&SCHWARZ

*Please visit us online:*
*www.rohde-schwarz.com*

**Available resources**

| | |
|---|---|
| White Paper | 1MA182: NFC Technology and Measurements |
| Product Broschure | R&S®FS-K112PC NFC Measurement Software |
| Video | RF Measurements for Near Field Communication (NFC with the R&S®RTO) |
| Webinar | Near Field Communication Technology and Measurements |